

What is claimed is:

1. An apparatus for converting an axial rotational motion of a drive shaft to a linear reciprocating motion to drive a piston, the apparatus comprising:
 - a. a cam, wherein the cam comprises:
 - i. a generally cylindrical body portion; and
 - ii. a drive-shaft connector, wherein the drive-shaft connector is:
 1. a threaded connection between the drive shaft and the cam, and
 2. located along an eccentric axis of the cam;
 - b. a plurality of bearings, wherein the plurality of bearings are operatively positioned around the cam; and
 - c. a planetary, wherein the planetary comprises:
 - i. a generally cylindrical opening adapted to be operatively positioned around the plurality of bearings; and
 - ii. a follower connector, wherein the follower connector is adapted to be part of an operable connection between the planetary and the piston.
2. The apparatus according to claim 1, wherein the drive shaft rotates in the opposite direction to the handedness of the threaded connection between the drive shaft and the cam, whereby the rotation of the drive shaft tends to maintain the threaded connection.
3. The apparatus according to claim 2, wherein the cam further comprises: a second bore in the cam, wherein the second bore has an axis that is eccentric to the threaded connection between the drive shaft and the cam, whereby a rod can be inserted into the second bore for knocking and loosening the threaded connection between the drive shaft and the cam.
4. The apparatus according to claim 1, wherein the threaded connection between the drive shaft and the cam comprises: (a) a female threaded bore in the cam; and (b) a male threaded end on the drive shaft, wherein the male threaded end on the drive shaft corresponds to the female threaded bore in the cam.

5. An apparatus for converting an axial rotational motion of a drive shaft to a linear reciprocating motion to drive a piston, the apparatus comprising:
- a. a cam, wherein the cam comprises:
 - i. a generally cylindrical body portion; and
 - 5 ii. a drive-shaft connector, wherein the drive-shaft connector is:
 - 1. adapted to be part of an operable connection between the drive shaft and the cam, and
 - 2. located along an eccentric axis of the cam;
 - b. a bearing assembly operatively positioned around the cam, wherein the
10 bearing assembly comprises:
 - i. a plurality of bearings;
 - ii. an outer race for the plurality of bearings;
 - iii. an inner race for the plurality of bearings, wherein the inner race
is adapted to be positioned around the cam in an interference fit;
 - 15 c. a planetary, wherein the planetary comprises:
 - i. a generally cylindrical opening adapted to be operatively
positioned around the bearing assembly, wherein the opening in
the planetary is adapted to be positioned around the bearing
assembly in an interference fit; and
 - 20 ii. a follower connector, wherein the follower connector is adapted
to be part of an operable connection between the planetary and
the piston.
6. The apparatus according to claim 5, wherein the bearing assembly further comprises: a ball cage for the plurality of bearings.
7. The apparatus according to claim 5, wherein the bearing assembly further comprises: a bearing shield.
8. The apparatus according to claim 5, wherein the bearing assembly is operatively positioned around the cam by pressing the cam in an interference fit into the inner race of the bearing assembly.

9. The apparatus according to claim 5, wherein the opening of the planetary is operatively positioned around the bearing assembly by pressing the outer race of the bearing assembly in an interference fit into the opening of the planetary.
10. The apparatus according to claim 5, wherein the opening of the planetary further comprises a lip for assisting in axially retaining the bearing assembly in the opening.
11. The apparatus according to claim 5, wherein the opening of the planetary further comprises a back for assisting in positioning and axially retaining the bearing assembly in the opening.
12. The apparatus according to claim 11, wherein the back of the opening of the planetary has at least one aperture for assisting in removing the bearing assembly from the opening.
13. The apparatus according to claim 5, wherein the opening of the planetary is operatively positioned around the plurality of bearings by pressing the outer race of the bearing assembly in an interference fit into the opening of the planetary.

14. An apparatus for converting an axial rotational motion of a drive shaft to a linear reciprocating motion to drive a piston, the apparatus comprising:
- a. a cam, wherein the cam comprises:
 - i. a generally cylindrical body portion; and
 - ii. a drive-shaft connector, wherein the drive-shaft connector is:
 - 1. adapted to be part of an operable connection between the drive shaft and the cam, and
 - 2. located along an eccentric axis of the cam;
 - b. a plurality of bearings, wherein the plurality of bearings are operatively positioned around the cam;
 - c. a planetary, wherein the planetary comprises:
 - i. a generally cylindrical opening adapted to be operatively positioned around the plurality of bearings; and
 - ii. a follower connector, wherein the follower connector has a generally cylindrical surface adapted to be part of an operable connection between the planetary and the piston;
 - d. a follower, wherein the follower has a generally cylindrical surface adapted to correspond to the generally cylindrical surface of the follower connector, and wherein the follower is adapted to be part of an operable connection between the planetary and the piston; and
 - e. a self-lubricating sleeve for reducing friction between the corresponding cylindrical surfaces of the follower connector and the follower.
15. The apparatus according to claim 14, wherein the follower connector of the planetary is eccentrically located relative to the generally cylindrical opening in the planetary for the plurality of bearings and the follower connector and follower have a rocking connection.
16. The apparatus according to claim 15, wherein the planetary further comprises: a second follower connector, wherein the second follower connector is adapted to be part of an operable connection between the planetary and a second piston.

17. The apparatus according to claim 16, wherein the second follower connector of the planetary is located the same eccentric distance from the generally cylindrical opening in the planetary for the plurality of bearings and at 90 degrees relative to the second opening.
18. The apparatus according to claim 16, wherein the second follower connector is adapted to be part of an operable connection between the planetary and a second piston, wherein the axes of the pistons are not parallel to one another.
19. The apparatus according to claim 18, wherein the angle between the non-parallel axes of the pistons is 90 degrees.
20. The apparatus according to claim 16, wherein the follower connector is a substantially cylindrical second opening in the planetary.
21. The apparatus according to claim 20, wherein the follower connector is a substantially cylindrical projection on the planetary.
22. The apparatus according to claim 20, wherein the follower comprises:
 - a. a substantially cylindrical pin that is adapted to be received in the second opening of the planetary; and
 - b. means for engaging a portion of the piston.
23. The apparatus according to claim 22, wherein the means for engaging the piston comprises:
 - a. a head having piston bore adapted to receive a portion of the piston; and
 - b. a means for retaining the piston in the piston bore.

24. The apparatus according to claim 23, wherein the means for retaining the piston in the piston bore of the follower comprises:
- a. a threaded bore in the head perpendicular to the piston bore; and
 - b. a screw adapted to tighten against the portion of the piston positioned in the piston bore.
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25. The apparatus according to claim 23, wherein the means for retaining the piston in the piston bore of the follower comprises:
- a. female threads in the piston bore; and
 - b. corresponding male threads on the end of the piston.

26. An apparatus for converting an axial rotational motion of a drive shaft to a linear reciprocating motion to drive a piston, the apparatus comprising:

- a. a cam, wherein the cam comprises:
 - 5 i. a generally cylindrical body portion; and
 - ii. a drive-shaft connector, wherein the drive-shaft connector is:
 - 1. adapted to be part of an operable connection between the drive shaft and the cam, and
 - 2. located along an eccentric axis of the cam;
- 10 b. a plurality of bearings, wherein the plurality of bearings are operatively positioned around the cam;
- c. a planetary, wherein the planetary comprises:
 - i. a generally cylindrical opening adapted to be operatively positioned around the plurality of bearings; and
 - 15 ii. a follower connector, wherein the follower connector has a generally cylindrical surface adapted to be part of an operable connection between the planetary and the piston;
- d. a follower, wherein the follower has a generally cylindrical surface adapted to correspond to the generally cylindrical surface of the follower connector, and wherein the follower is adapted to be part of an operable connection between the planetary and the piston; and
- 20 e. a plurality of needle bearings for reducing friction between the corresponding cylindrical surfaces of the follower connector and the follower.

27. A fluid pump comprising:

- a. a piston;
- b. a bushing adapted for the piston;
- 5 c. a bushing retainer having an aperture through which the piston can reciprocate;
- d. a pump body defining:
 - i. a pumping chamber having a first port adapted to receive a suction valve assembly and a second port adapted to receive a discharge valve assembly;
 - 10 ii. a piston bore communicating with the pumping chamber, the piston bore adapted to receive the piston and the bushing; and
 - iii. a slot adapted to slidably receive the bushing retainer to securely retain the bushing in the piston bore of the pump body.

28. The fluid pump according to claim 27, wherein the bushing is part of a bushing assembly comprising: a sealing ring toward the bottom of the piston bore and a sealing ring toward the upper end of the piston bore.

29. The fluid pump according to claim 27, further comprising a discharge valve assembly, wherein the discharge valve assembly comprises:

- a. a housing defining an interior cavity ending at a shoulder;
- b. a coil spring positioned in the cavity of the housing to engage the shoulder of the cavity;
- 5 c. a poppet valve having a disk shaped body portion with a rim, the poppet valve positioned to engage the coil spring;
- d. a washer having a groove formed therein, wherein the washer is positioned to engage the rim of the poppet valve; and
- 10 e. an o-ring positioned adjacent the groove of the washer, whereby the washer and the o-ring are adapted to land on a corresponding rim of the second port of the fluid pump.

30. A discharge valve assembly for a fluid pump, the discharge valve assembly comprising:
- a. a housing defining an interior cavity ending at a shoulder;
 - b. a coil spring positioned in the cavity of the housing to engage the shoulder of the cavity;
 - c. a poppet valve having a disk shaped body portion with a rim, the poppet valve positioned to engage the coil spring;
 - d. a washer having a groove formed therein, wherein the washer is positioned to engage the rim of the poppet valve; and
 - e. an o-ring positioned adjacent the groove of the washer, whereby the washer and the o-ring are adapted to land on a corresponding rim of a discharge port of the fluid pump.
31. The discharge valve assembly according to claim 30, wherein the housing has an internally threaded bore adapted for receiving a discharge valve fitting.
32. The discharge valve assembly according to claim 30, wherein the housing has a male threaded portion adapted for screwing the discharge valve housing into a threaded connector of the discharge port of the fluid pump.
33. The discharge valve assembly according to claim 30, wherein the cavity is bell shaped.
34. The discharge valve assembly according to claim 30, wherein the coil spring is generally conical in shape having a larger-diameter base portion and a smaller-diameter head portion, wherein the larger-diameter base portion engages the shoulder of the cavity and the smaller-diameter head portion engages the poppet.
35. The discharge valve assembly according to claim 34, wherein the poppet has a central cylindrical knob for engaging the smaller-diameter head portion of the coil spring.

36. An apparatus for pumping a fluid, the apparatus comprising:

a. a pump, wherein the pump comprises:

i. a piston;

5 ii. a bushing adapted for the piston;

iii. a bushing retainer having an aperture through which the piston
can reciprocate;

iv. a pump body defining:

1. a pumping chamber having a first port adapted to receive
10 a suction valve assembly and a second port adapted to
receive a discharge valve assembly;

2. a piston bore communicating with the pumping chamber,
the piston bore adapted to receive the piston and the
bushing; and

15 v. a slot adapted to slidably receive the bushing retainer to
securely retain the bushing in the piston bore of the pump body;
and

b. a motion converting apparatus for converting an axial rotational motion
of a drive shaft to a linear reciprocating motion to drive the piston of
20 the pump, wherein the motion converting apparatus comprises:

i. a cam, wherein the cam comprises:

1. a generally cylindrical body portion; and

2. a drive-shaft connector, wherein the drive-shaft
connector is:

25 a. adapted to be part of an operable connection
between the drive shaft and the cam, and

b. located along an eccentric axis of the cam;

ii. a plurality of bearings, wherein the plurality of bearings are
operatively positioned around the cam; and

30 iii. a planetary, wherein the planetary comprises:

1. a generally cylindrical opening adapted to be operatively
positioned around the plurality of bearings; and

2. a follower connector, wherein the follower connector is
adapted to be part of an operable connection between the
35 planetary and the piston.